Meet The Original Hyperloop... For Rocks

Posted Aug 21, 2013 by John Biggs (@johnbiggs)

The Hyperloop isn't a new idea. In fact, the concept was so compelling that an engineer named Stephen Fairfax built one to carry phosphate ore back and forth through a mine. Because the entire system needed to survive in a dank, dirty environment and have as few moving parts as possible, a Hyperloop-like maglev system made perfect sense. He spent four years – from 1996 to 2000 – building a demo unit that could move 3 million tons of ore per year at a phosphate mine. The resulting system (you can see it shuttling back and forth here) is a cross between Mad Max and Epcot Center.

Fairfox offered a bit of insight on his project to go along with his thorough video walkthrough recorded in the pre-YouTube days. It's a fascinating look at the future of travel – and the potential of maglev-style systems. In short, this proves that Hyperloop-like systems work, are fairly maintenance free, and can be used to haul tons of freight. It also proves that ideas like the Hyperloop can work – for a price. Fairfax would even consider building a real Hyperloop with the right amount of investment.

TechCrunch: Tell us how you built this prototype.

Stephen Fairfax: The ore car demonstration was an outgrowth of Magplane, a magnetically levitated train concept.

I knew the Magplane principles, and criticized the idea that people would get on a vehicle flying at 700 MPH just a few inches from a track. I said they should start with cargo that doesn't need lights, bathrooms, seat belts, fresh air, and similar amenities. Once the bugs were worked out, move on to passenger service if it made sense.

They called my bluff when they got a contract for the ore car demo. None of the Magplane people had much experience building actual hardware. My specialty is doing the work that turns cool concepts, like a fusion reactor or an ore transport, into a working system.

So I took the job, hired 6 engineers, and spent 1996 to 2000 working on the ore car demo. I designed the motors to survive in a harsh mining environment. The car was as simple as possible. Since ore isn't in a hurry, the design optimized at 40 MPH rather than 700 MPH. We didn't need the expense or complexity of magnetic levitation, and found some very rugged wheels made for mining applications. They worked great.

The basic goal of the project was to develop a demonstration system. The demonstration was to show all the relevant technical features and performance of a system that would move 3 million tons of ore per year within a large phosphate mine. If successful, the next phase would be construction of a 30+ mile pipeline from the mine to the port of Tampa. Like Hyperloop, there was talk of using interstate highway right of way. I always thought it would be cheaper and faster to buy private easements, but we never got that far in any case.

TC: Why a mine car? What was the impetus for the design?

SF: The world uses a lot of phosphoric acid and phosphate fertilizer. Massive quantities of phosphate rock are moved every year. The cost of transport is a significant fraction of the cost of the final product. The ore car system was intended to dramatically lower the cost of transporting ore to the processing mill.

A major part of the challenge is the frequent power outages due to lightning storms. We had to design the ore car system so that it could be restarted after a power failure.

TC: How did you fix that?

SF: Hyperloop correctly notes that a capsule moving in a pipeline can act as a plug, pushing a lot of air ahead of it. They propose an interesting solution with a compressor turbine in the front of the vehicle.

I made a virtue of necessity in the ore car. The “kick” motors were spaced every 1000 meters or so, depending on topography. In a power failure, I knew that the cars would stop everywhere but over a kick motor.

So we used the plugging of the pipeline to our advantage. After a power failure, we would simply start firing capsules into the pipeline using the linear accelerator at the beginning. The capsules push a load of air in front of them. As the air between the moving capsule and the stationary capsules in the tube compresses, the stationary capsules are accelerated. Once they reach a kick motor, they are accelerated some more.

In this way, the system could be restarted after a complete power failure. In a similar vein, if any given kick motor failed, or a motor in the accelerator section, the system would just operate at a slightly reduced speed until repairs are complete.

TC: Did it ever work?

SF: We could meet our 3 megaton/year goal if we could keep the capsules rolling 16 hours a day, 85% of the days. That gave us some margin for failures, power outages, reduced speeds, etc. The project was technically successful, but during the four years of work the market price

of phosphate ore declined significantly. There was no desire for major new capital investments. We were never paid for the final few invoices.

People who know power electronics will probably criticize my choice of motor drives. I chose cheap, rugged drives. I bought the development unit used using a credit card over the internet – which was unusual in 1997!

The drives were rated 100 kW average power but we used them at peak power approaching 1 MW. We designed custom control electronics that changed the rotary induction motor drives into linear synchronous motor drives.

TC: So we can make a longer one? That goes really fast?

SF: If I were to do the project today the control system and motor drives would use different technology, but the basic physics and control laws are the same. It's actually easier to do this today.

My firm has worked on modern motor drives powering loads up to 180 MW, so I agree with Mr. Musk's conclusion that the size and performance of the drives is not an issue.

I would take a hard look at the use of eddy current levitation, which would allow the vehicle to fly about 30 cm (1 foot) above the tube. This would greatly reduce the dimensional tolerances required. That in turn would lower costs and make the system more robust to minor movements. A 1200 km tube is going to move, it is only a question of how far and how often.

I would also like to explore the use of conventional gas turbine engines to power to the compressor and other loads. It could use clean fuel like LNG, but I can buy those engines today, with people-rated safety features already demonstrated. They hang beneath airplane wings and in power plants right now. I can trade a lot of fuel for the size, weight, and expense of batteries.

I would also want to explore heat balance in the tubes, and there needs to be a lot more thought given to failure modes and effects. That's not a criticism of the concept, just a statement of work that must be done.

There's lots to talk about. Like Mr. Musk, I have a business to run. Unlike Mr. Musk, I have not amassed a great personal fortune. I'm afraid my involvement in Hyperloop development will be limited unless there are customers who would like to fund a demonstration system. I'd be

happy to assist with that venture.

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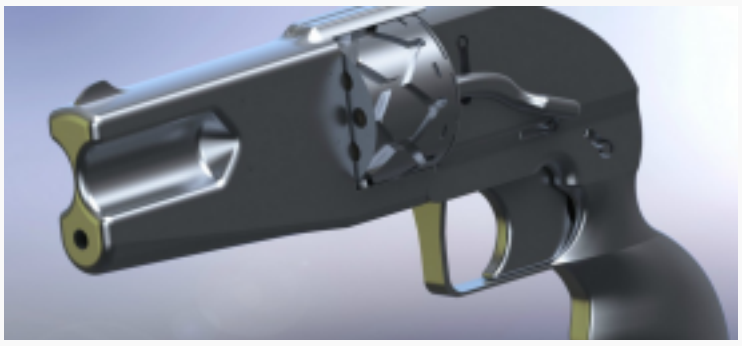

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chyang888 Aug 26, 2013

I like this guy. Spoken like a real engineer with real experience in terms of process, safety, and cost. Musk should consider contracting Fairfax to do some exploratory work for him. The idea of using CNG powered turbine instead of electric motor turbine is worth considering.

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nice ,,,

http://nice2design.com/

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Where is the crowdsourcing campaign for a new demo?

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20 July 21 Alice in Xingshan District of yellow **national soccer uniforms** grains trapped when **team soccer jerseys** Peacock Valley Outdoor Adventures, one of **team soccer jerseys** whom died wounded died.

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This is getting very interesting! Does Elon Musk know about this?

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Sign the White house petitions to fund the Hyperloop.

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https://petitions.whitehouse.gov/petition/fund-testing-and-building-elon-musks-hyperloop/NfTcBxqK

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Its a great solution for moving rocks, sand and other materials. Moving humans is a different game. If there is a technical outage and you are stuck in a tube without oxygen, it could be a catastrophe.

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JoshJacob Aug 21, 2013

Stephen Fairfax is the long lost brother of Wilford Brimley

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NikhilKumar Aug 21, 2013

it faster then other..**http://t.co/m4e53CH5**

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ShawnPurcell Aug 21, 2013

Another example of an active hyperloop is the "Endless River" at Raging Waters water park. (hee hee).

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Eli Aug 21, 2013

@ShawnPurcell lol!

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frippe Aug 21, 2013

Must have been taken from 007 in "The Living Daylights" from 1987 - running in a pipline cleaner pod...

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Madlyb Aug 22, 2013

@frippe Pigs are different. They are simply pushed by the gas or fluid contained in the pipeline.

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